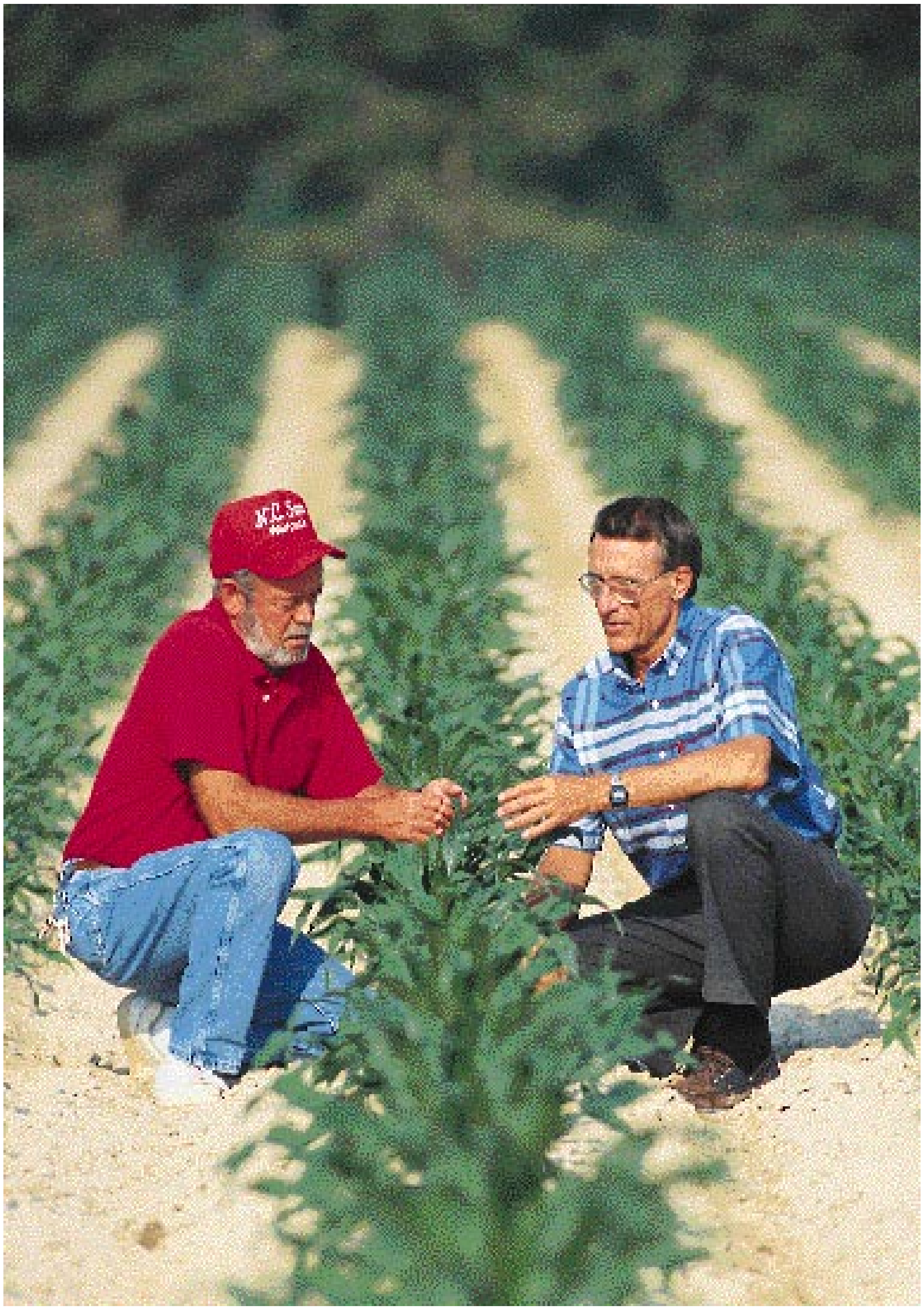
# Precision Breeding Makes Better Corn—Faster

SCOTT BAUER




**Plant geneticist Charles Stuber (right) and technician Wayne Dillard examine plants grown from a hybrid cross between enhanced corn lines. (K7341-12)**

In 1972, Charles W. Stuber, a plant geneticist with USDA's Agricultural Research Service and professor of genetics at North Carolina State University, published a paper on corn breeding that helped start a revolution.

He had found that tracing an individual corn plant's genetic makeup provided breeders with much more precision in choosing which plants to cross for increased yield in future generations.

Before, scientists assumed that grain yield, a trait improved by many genes, could be enhanced only by traditional breeding methods that can take up to 10 years to create a new hybrid. This new method—using genetic markers that detect the location of genes with desirable traits—should cut that time in half.

Last year, Stuber was honored by the Crop Science Society of America and the National Council of Commercial Plant Breeders for his work in this area. But like many revolutionaries, he had a hard time convincing his colleagues to accept his findings.

"The first time I heard Stuber discuss his ideas was at a conference in California. I was a bit skeptical—it seemed too good to be true," says plant geneticist John Dudley, a professor at the University of Illinois in Urbana. But "what he showed us that day is now a major part of my research program. It's obviously changing the direction of plant breeding."

Dudley adds that the change is evident in the money commercial seed companies are investing to use Stuber's concepts. These new tools will help them develop the next generations of high-yielding varieties.

To understand this new form of precision breeding, which is rapidly gaining popularity in the seed world, it helps to retrace the steps of one of Stuber's experiments.

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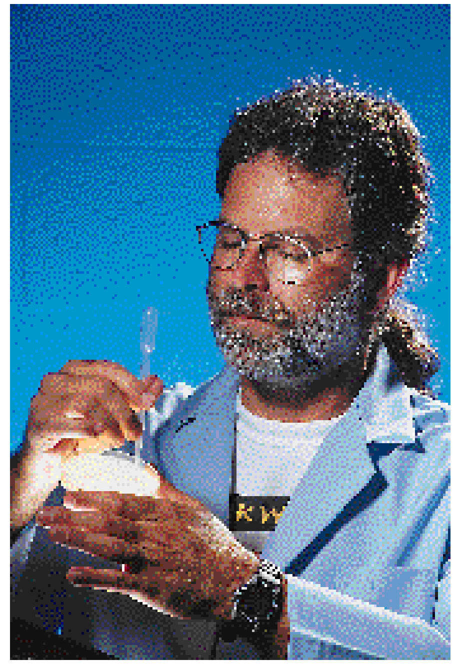

**Technician David Rhyne removes phage plaque containing a clone that will be developed into a new microsatellite DNA marker. (K7344-9)**

"To start with, there are two main gene pools normally used to produce U.S. corn hybrids—Iowa Stiff Stalk Synthetic and Lancaster Sure Crop," explains Stuber. "Conventional breeders say any commercial hybrid should have one parent from each of these pools.

"As it happens, inbred line B73 from Stiff Stalk and inbred line Mo17 from Lancaster are parents of a high-yielding hybrid. But they lack some pieces of the genetic puzzle that could make their progeny blockbuster producers," says Stuber.

"Careful analysis of genetic maps reveals other lines have some of these parts. For B73, Tx303 from Texas has some of the right parts. For Mo17, it's Oh43 from Ohio. We use molecular markers to guide the transfer of these key genetic elements into the choice parents."

Stuber first crosses B73 with Tx303. The result is plants with one-half B73 genes and one-half Tx303 genes—call this generation one. Stuber then crosses generation one with B73 again—producing generation two. Generation two is crossed with B73 one more time to get generation three. Finally, Stuber analyzes the genetic complements of generations two and three to find offspring plants that are like B73, except that they contain the desired Tx303 gene factor.

"Those special plants are enhanced B73's," Stuber says.

"Then we make the same kinds of crosses with Mo17 and Oh43 to create an enhanced version of Mo17. Cross your enhanced parents—and you have what we might call generation X corn."

Generation X corn outperforms the cross between regular B73 and Mo17 inbred lines by as much as 15 percent, or about 20 bushels per acre. But surprisingly, it also surpasses the yield of existing commercial varieties by as much as 10 to 15 percent.

Right now, several varieties of generation X corn are being tested by commercial breeders, and the results show that precision breeding is the way of the future.

"It's like you had a soup and somebody gave you a bag of seasonings and said, 'Some of these will make your soup delicious—the rest will make it taste awful,'" says Scott Furbeck, who works in Indiana for Ciba Seeds. "Before, breeders would try things in various ratios and throw out a lot of soup. With Charlie's method, you can get the ingredients right the first time."

Furbeck, who studied under Stuber as a graduate student, says this new form of precision breeding also allows breeders to backtrack a generation and pick up needed traits from previous crosses. For example, you could have a high-yielding hybrid that lacks disease resistance found in its grandparents. Precision breeding lets researchers pick up the resistance gene and transfer it to later generations.

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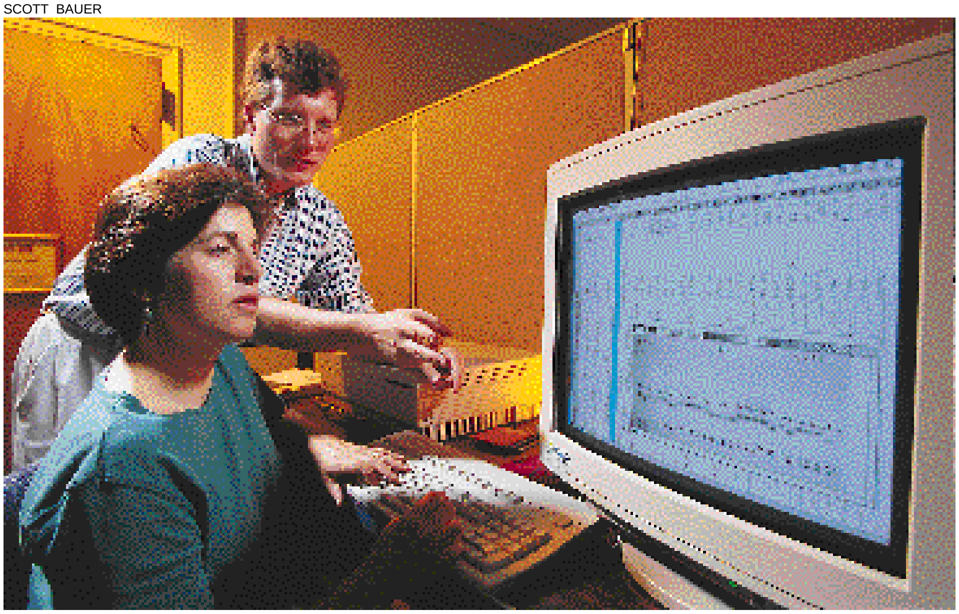

**Geneticists Lynn Senior and John LeDeaux enter genetic test results into a computer database for statistical analyses. (K7344-8)**

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Geneticist Charles Stuber and technician Dianne Beattie discuss the scoring of isoenzyme markers. (K7343-19)

The research has also drawn the attention of the international scientific community. Stuber has given talks on marker-facilitated breeding in New Zealand and Spain. Most recently, Martin Ganal, who is with the Institute for Plant Genetics and Crop Plant Research in Gatersleben, Germany, invited Stuber to speak.

He says, “Dr. Stuber is one of the first researchers to use molecular markers for mapping genetic traits of maize chromosomes.

“This information will open the door to a directed manipulation of complex traits. It will also open the door to discovering how genes responsible for such traits work.”

But precision breeding could become even more important in the future in protecting U.S. corn. Exotic corn varieties with enhanced disease resistance and other special qualities are constantly being discovered. Farmers will want these new traits in the domestic gene pool quickly, without sacrificing yield.

Martin L. Carson, a colleague of Stuber’s, is working on an ARS-funded project called GEM—for Germplasm Enhancement of Maize. Under this project, corn varieties native to the Caribbean, Central America, Bolivia, Brazil, and Peru will be evaluated in cooperation with the commercial seed industry to see what helpful traits can be transferred to U.S. lines.

The project is a follow-up to one funded by Pioneer Hi-Bred International of Johnston, Iowa, in which 23,000 Latin American corn cultivars were evaluated.

Another advantage of precision breeding is that the environment is eliminated as a confusing factor in research. Naturally, all new corn varieties have to be tested in various growing climates, and Stuber’s research team does this.

But environmental factors, such as weather, can get in the way when you’re trying to verify whether a particular trait was passed on—especially in the case of yield.

Some traits are immune to environmental influence. For example, if a pea inherits wrinkled seed from its parents, that’s what it will produce—no matter how dry or wet the growing conditions are.

But a corn variety with dynamite genes for yield can fizzle out if the growing season is too wet or too dry.

“Precision breeding allows researchers to see a plant’s potential before exposing it to weather conditions,” Stuber says.

In the future, precision breeding may also be used to enhance animal stock, as well as plant varieties. There has already been discussion at ARS about its potential.

The few pioneers in precision plant breeding have been joined by the rest of the industry, many of whom are taking the original science to new levels. And advances in computer research are contributing to precision breeding’s success.

Meanwhile, Stuber is going on more lecture tours and publishing more papers. His generation X corn, now being tested against commercial varieties, may soon be part of a new class of corn varieties that will be available to farmers before the year 2000.—By **Jill Lee,** ARS.

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